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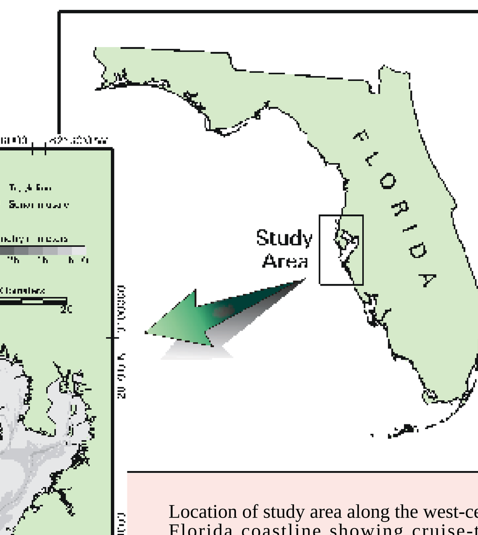
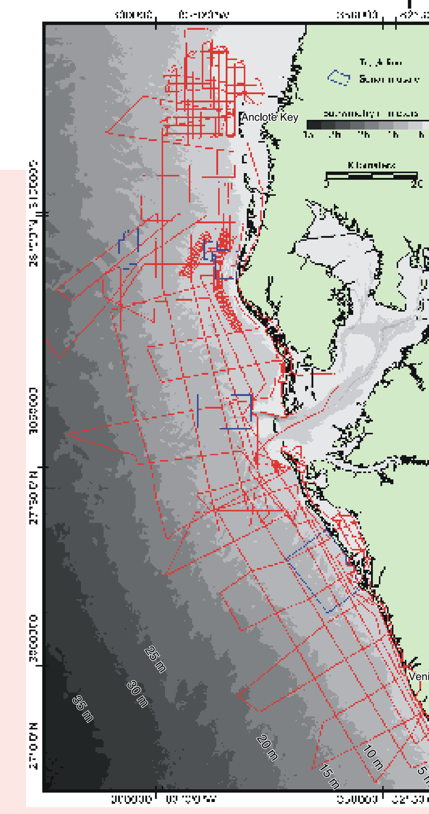
West-Central Florida Coastal Transect # 1: Anclote Key

S.D. Locker,[1] A.C. Hine,[1] R.A. Davis,[2] G.R. Brooks,[3] and K.K. Guy[4]

[1] College of Marine Science, University of South Florida, St. Petersburg, FL 33701 [2] Department of Geology, University of South Florida, Tampa, FL 33620 [3] Department of Marine Science, Eckerd College, St. Petersburg, FL 33711 [4] U.S. Geological Survey, St. Petersburg, FL 33701





Location of study area along the west-central Florida coastline showing cruise-track coverage in red. Data types include high-resolution seismic-reflection data, side-scan sonar imagery, surface-sediment samples, and vibracores. Blue-box areas identify continuous-coverage side-scan sonar mosaic areas. The bathymetry shown in 5-m intervals by gray shading is modified from Gelfenbaum and Guy (1999).

Introduction

A major goal of the West-Central Florida Coastal Studies Project was to investigate linkages between the barrier-island system along the west coast of Florida and offshore sedimentary sequences. High population density along this coastline and the resultant coastal-management concerns were primary factors driving the approach of this regional study. Key objectives were to better understand sedimentary processes and sediment accumulation patterns of the modern coastal system, the history of coastal evolution during sea-level rise, and resource assessment for future planning. A series of nine "swath" transects, extending from the mainland out to a depth of 26 m, was defined to serve as a focus to merge the data sets and for comparison of different coastal settings within the study area.

Transect #1 crosses the northern end of Anclote Key (see location map to right). Information from seismic and vibracore studies is combined to derive a 2-D stratigraphic cross section extending from the offshore zone, through the barrier island, and onto the mainland. This stratigraphic record represents the late Holocene evolution of the coastal-barrier system and inner shelf following the last sea-level transgression and present highstand conditions. A comparison to surface-sediment distribution patterns indicated by side-scan sonar imagery and bottom grab samples illustrates the importance of spatial variability in sediment-distribution patterns offshore when considering stratigraphic interpretations of seismic and core data.

Methods

Geophysical surveys in 1988 and 1994 acquired high-resolution single-channel "boomer" seismic data and 100-kHz side-scan sonar imagery (Blake and others, 1989; Locker and others, 2001). Additionally, underway bottom samples were collected in 1994 at 4-km intervals along track. Offshore core locations were selected based upon seismic data and were focused in areas likely to contain sufficient sediment thickness for core retrieval. Vibracores and probe data provided stratigraphic control in the barrier-island and bay areas.

The four panels showing location and side-scan sonar imagery, seismic data, and a stratigraphic cross section are at the same horizontal scale. The seismic profile and cross-section panels are constructed by fitting the data between the labeled cross-section turns (upper location map panel) that have been projected straight downward to the cross-section line. Subtle deviations in the horizontal scale of segments in the cross section due to this projection are minimal. The horizontal scale, as well as vertical exaggeration of the seismic profile and cross section, are the same for all nine transects in the map series in order to facilitate comparison among transects.

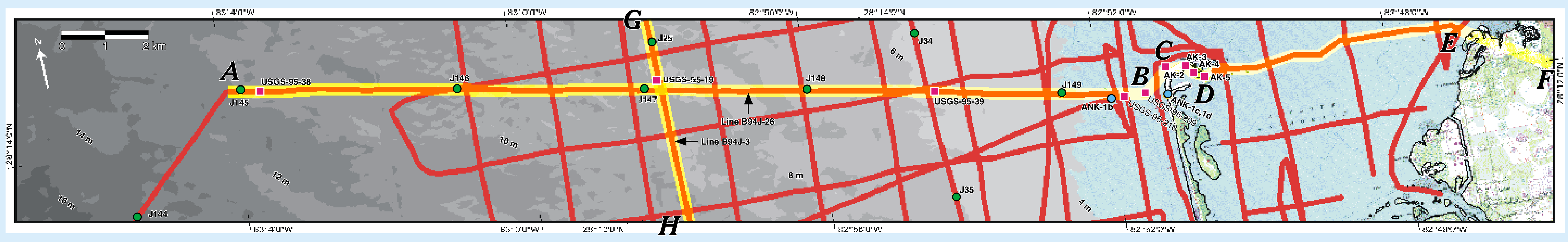
Geologic History and Morphodynamics of Barrier Islands

Barrier islands on the west-central Gulf coast of Florida display a wide range in morphology along the most diverse barrier/inlet coast in the world (Davis, 1994). In addition, the barriers have formed over a wide range of time scales from decades to millennia. The oldest of the barriers have been dated at 3,000 years (Stapor and others, 1988) and others have formed during the past two decades. The barrier system includes long, wave-dominated examples as well as drumstick barriers that are characteristic of mixed wave and tidal energy. Historical data on the very young barriers and stratigraphic data from coring older ones indicate that the barriers formed as the result of a gentle wave climate transporting sediment to shallow water and shoaling upward to intertidal and eventually supratidal conditions. The barriers probably formed close to their present position and several have been aided in their location and development by antecedent topography produced by the shallow Miocene limestone bedrock (Evans and others, 1985). The two most important variables that control barrier-island development along the coast are the availability of sediment and the interaction of wave and tidal energy.

Anclote Key

Anclote Key is a wave-dominated barrier that is terminated at each end by an inlet-like environment that has only ephemeral shoals on the sides of the channels opposite the barrier. The island is situated 5 km from the mainland as a consequence of the antecedent topography produced by a break in slope on the underlying Miocene limestone (Evans, 1983; Kuhn, 1983; Davis and Kuhn, 1985; Evans and others, 1985). The island shows significant southerly growth over the past century in the form of recurved beach ridges. The north end of the island has grown by about 2 km since 1960 (Hine and others, 1987). The demise of a shallow seagrass community just offshore of Anclote Key in the late 1950's enabled the wave climate to rework significant sand and transport it landward and alongshore. The growth of the north end of the island is the direct result of the increased sediment supply.

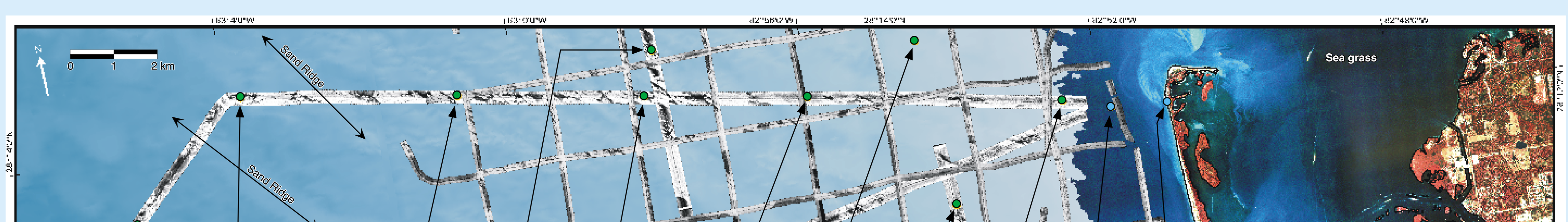
The stratigraphy of Anclote Key is rather straightforward. A thin and discontinuous muddy Pleistocene sand (Stage 5e) rests on the Miocene limestone throughout this area (Kuhn, 1983; Gregory, 1984). The basal Holocene unit is an organic-rich muddy sand that has been dated at 4,500 YBP near its base. This basal unit represents a vegetated paralic environment that persisted in the area until about 2,000-1,500 YBP when it became inundated and reworked by processes associated with a very slowly rising sea level. Clean quartz sand and shelly sand overlie this unit and represent a combination of wave-dominated shoals and spillover deposits. As aggradation continued, supratidal conditions were achieved and washover fans were prominent. These deposits have now become reworked by bioturbation and are now a muddy sand facies. Once supratidal conditions had developed, Anclote Key stratigraphy shows a clean sand and shelly sand on the Gulf side and muddy sand on the landward side. Washover was prominent until eolian deposition had produced dunes that rose about 2-3 m above sea level. The absence of significant storm surge on this coast for long periods of time has prevented washover. The last time that washover was likely to have occurred was during the 1921 hurricane when storm surge reached about 3 m.



Location map

Location map showing bathymetry, cruise-track coverage, core and sample locations, and location of figures. Evidence for shoreline change is shown by comparing the 1997 shoreline (black line) with the 1974 USGS quadrangle map. The center part of the island has accreted seaward along with northward migration of the north end. The full transect cross section A-F is presented below. An expanded view of the island portion of the transect C-D is shown at lower right. Line G-H locates the seismic profile shown at lower left.

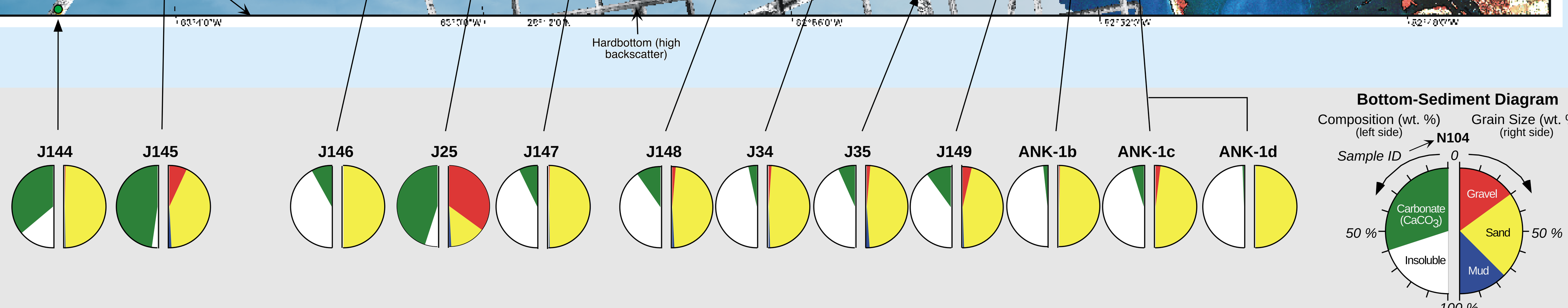
Vibracore
Underway surface-sediment sample
Surface-sediment grab sample
Cruise track in red with yellow highlight indicating line of cross section or seismic profiles (below).



Side-scan sonar data

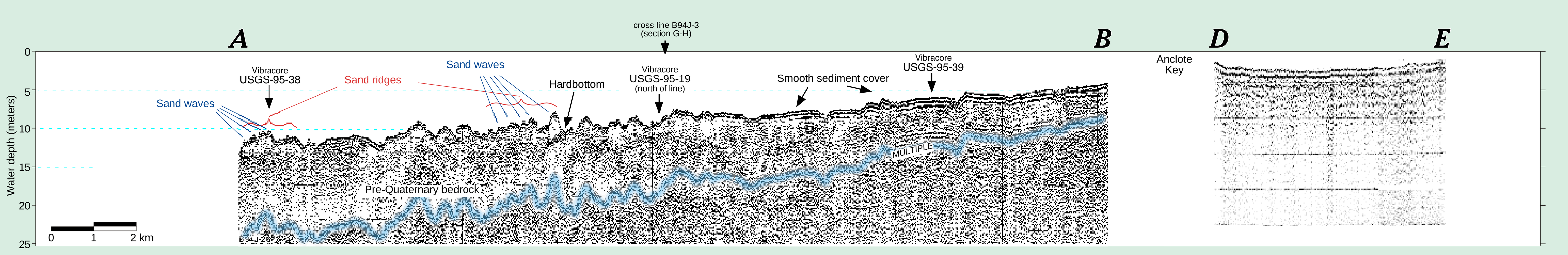
Side-scan sonar imagery overlain on bathymetry reveals a northwest-trending sand-ridge morphology in the outer half of the transect area – seaward of the 6- to 7-m isobath. Low backscatter (light gray) areas correspond to sand ridges and flats dominated by siliciclastic quartz sand. The dark (high backscatter) areas are largely coarse sediment veneer with increased carbonate material (primarily shell material), or some hardbottoms. A nearly continuous sediment cover exists landward of the 6-m isobath. Seagrass cover is dense in the back-barrier bay and north of Anclote Key. Sparse seagrass patches, detected in the sonar imagery, extend seaward to the 4- to 5-m isobaths (Locker and others, 2000).

Projection: UTM, GRS 1980, NAD83, Zone 17. Coordinates: Geographic.
Bathymetry (areas > 4 m) in continuous-tone blue colors after Gelfenbaum and Guy (1999).
Coastal areas (< 4 m) represented by Digital Orthophoto Quarter Quadrangle (1995).



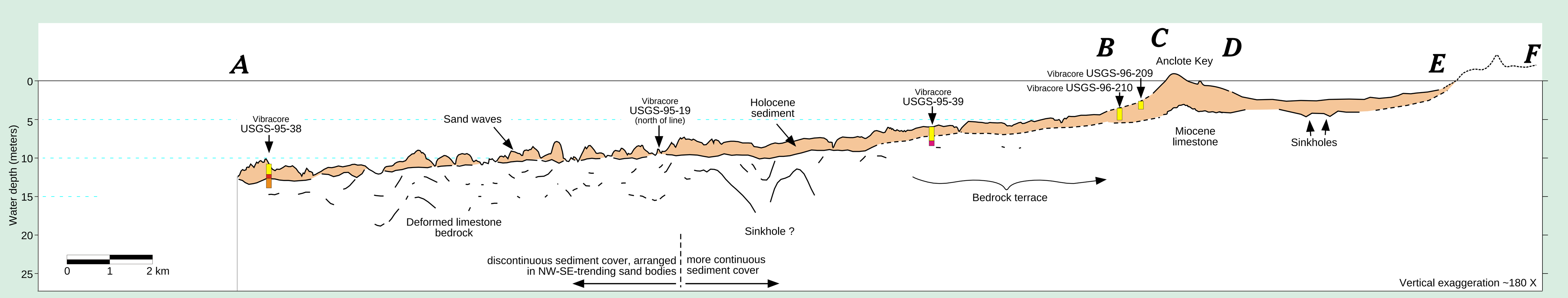
Surface sediments

Grain-size and composition data for bottom grab samples are presented below the sonar imagery. Samples generally consist of quartz-rich sand with subordinate amounts of gravel and mud (Brooks and others, 1999). Locally, samples are rich in carbonate gravel or sand. This is particularly noticeable in the outer portion of the transect. Low acoustic backscatter correlates with medium to fine siliciclastic sand with minor carbonate grains (sand ridge areas). The higher backscatter areas correlate with coarse grain size and increased carbonates in the inter-ridge lows or in hardbottom areas.



Seismic-profile data

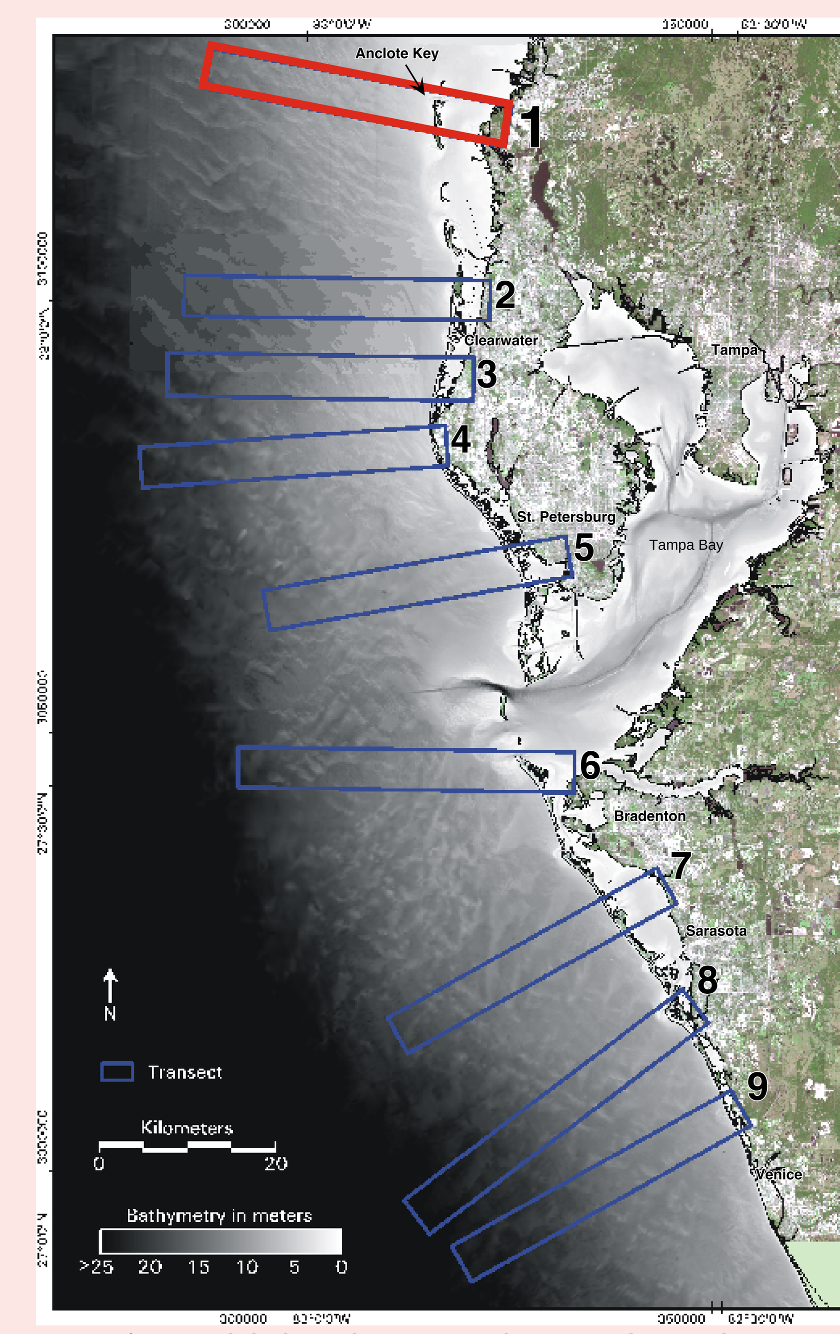
Uninterpreted high-resolution "boomer" seismic data show limited penetration and a change from more continuous sediment cover nearshore to a more discontinuous distribution of sand waves offshore. Poor acoustic contrast between the Holocene sediment cover and the underlying pre-Quaternary bedrock is attributed, in part, to the weathered nature of the Neogene bedrock. Additional evidence includes hardbottoms (pre-Holocene bedrock) and probe-rod measurements of sediment thickness (Blake and others, 1989). Some karst features are indicated (see below). The modern sediment cover is typically less than 2 m thick, corresponding with the higher relief portions of the sand waves and ridges seen here.



Transect cross section *A-F*

Integrated stratigraphic cross section combining interpretation of seismic data, ground truthed by coring, with a coastal cross section based on vibracores. Cores in the offshore transect have no cross-shelf correlation potential because they often contain isolated ridge deposits, shown in side-scan sonar imagery and bathymetry data. Hardbottom areas are associated with bathymetric lows in the offshore area (Locker and others, 2000). Whereas most of the sediment volume in this coastal system resides in the barrier-island section, there also is more continuous sediment cover in water depths of less than 7 m. The nearshore sediment cover is associated with a slightly elevated, and smoother, bedrock terrace seaward of Anclote Key.

Holocene sediment

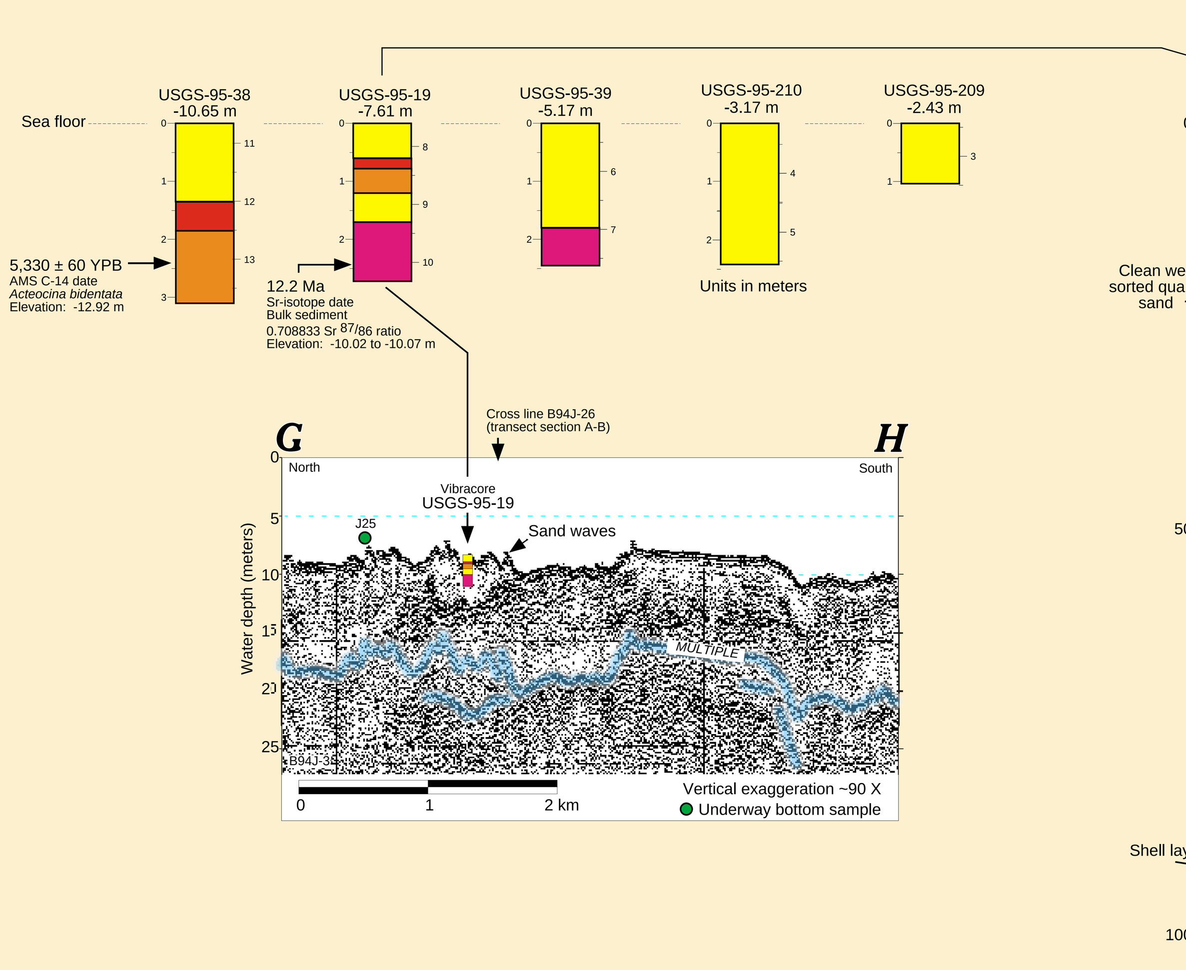


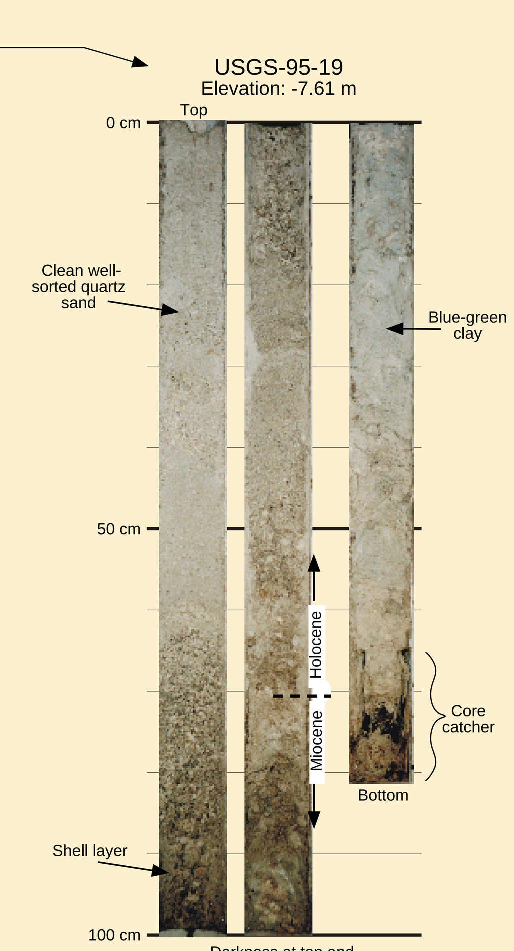
Location of west-central Florida coastal-transect maps with Transect #1 shown in red. 1997 LANDSAT TM imagery of Florida's west coast is merged with a bathymetric-surface model (Gelfenbaum and Guy, 1999). Bathymetric trends offshore in part reflect sediment-distribution patterns. The study area extends from Anclote Key to Venice, FL.

Oblique aerial photograph of the north end of Anclote Key showing the island-transect section C-D. A series of recurved spits (now vegetated) records accretion of the north end accompanied by constriction of the tidal channel during the past few decades (Hine and others, 1987). The intertidal shoal seen north of the island in the upper left became emergent in the mid-1990's.

Core Data

Offshore Cores

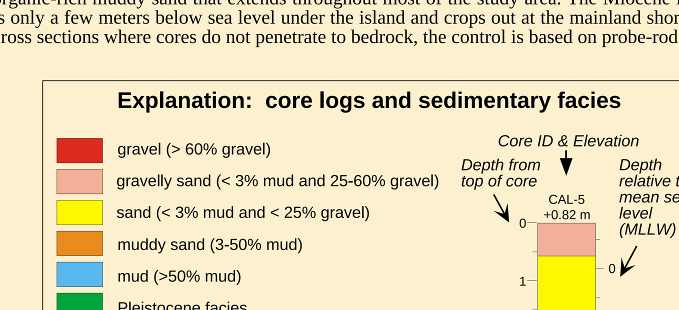




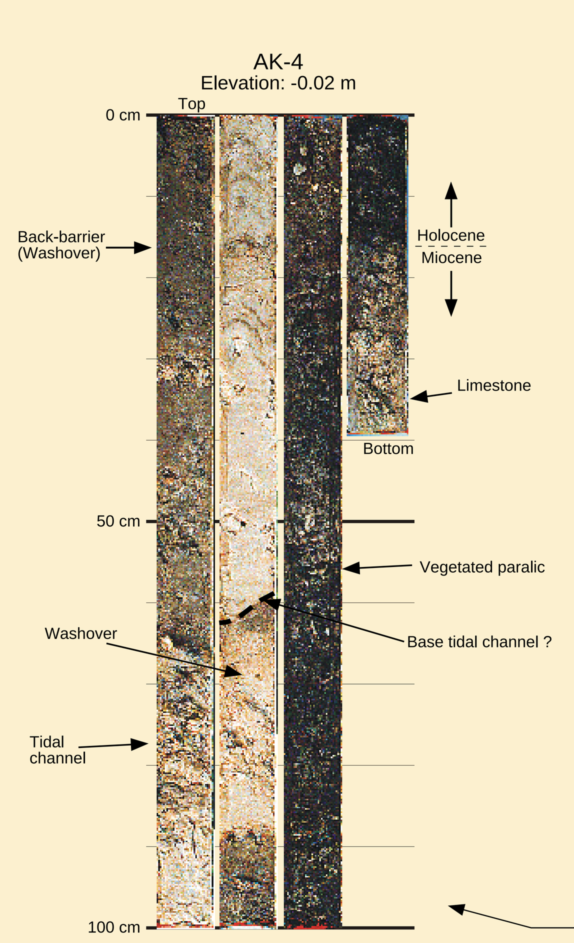
Seven generalized sedimentary-facies types were defined for a unified comparison of core data from the entire study area. All seven color-coded facies for the entire study are shown in the Explanation below. However, not all facies necessarily are present on each transect. Core photographs present individual cores cut into 1-m sections from top (upper left) to bottom (lower right). Discrepancies in core length between the photographs and the diagrams are due to compaction during the coring process. Offshore cores (left) are aligned at core tops. Core elevations were determined from water depth and tide tables. Core locations were chosen to sample thicker Holocene sections and to aid in identifying pre-Holocene stratigraphy. The datum for the barrier-transect cores is the mean lowest low water (MLLW).

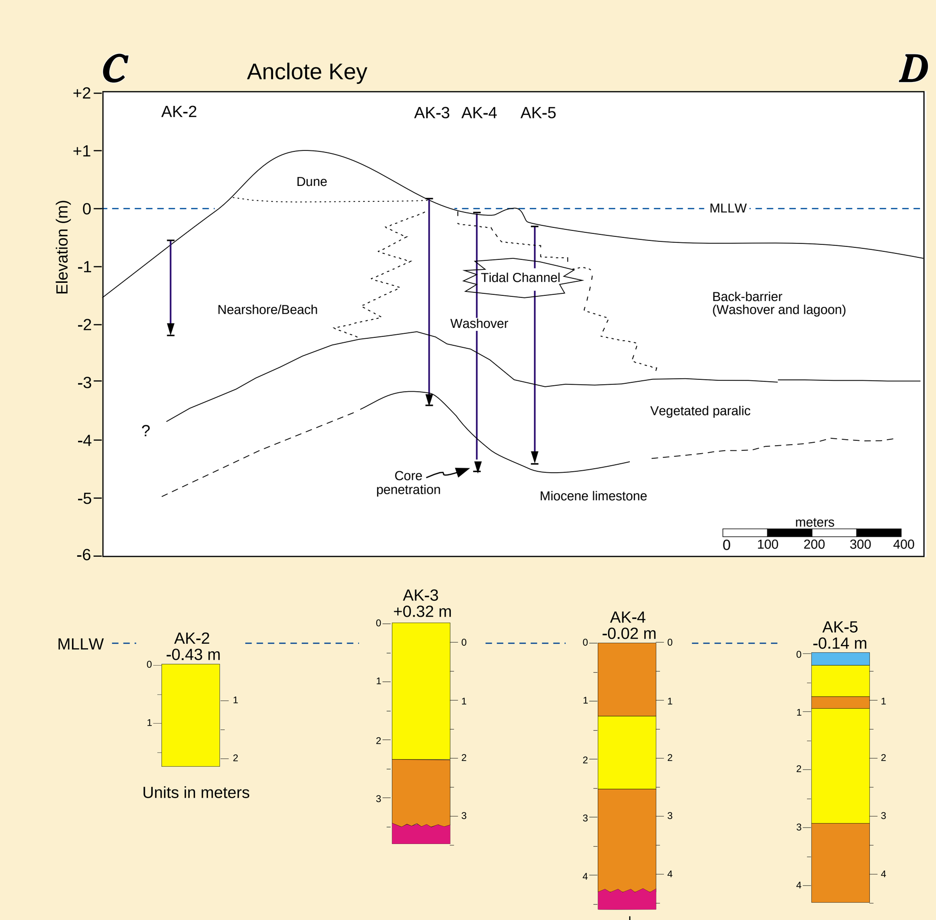
Offshore vibracore retrieval ranged from 1 to 3 m in length. Although the vibracores penetrated to bedrock, there is often little indication of a bedrock reflection seen in the seismic data above. A poor impedance contrast between the Holocene and underlying Neogene facies appears to be responsible for the lack of a well-defined seismic boundary (see seismic section G-H). All cores contain a surface layer dominated by quartz sands interpreted to be of open-marine origin. Underlying quartz sands in the two seawardmost cores are mud-rich sediments containing numerous burrows, and lagoonal foraminiferal assemblages. Mud-rich deposits are interpreted to be of back-barrier origin. The relatively thick sediment cover, dominance of quartz sands, and presence of back-barrier mud-rich sediments are consistent with a greater sediment influx in the northern part of the study area and may indicate barrier formation at least 20 km offshore during the Holocene sea-level rise.

In the two landwardmost cores, the Miocene limestone surface was penetrated immediately below the surficial sand layer. The higher elevation (above -5 m) of the bedrock terrace below Anclote Key is reflected in the thinner sediment thickness of the barrier-island section. The island cross section shown to the right (Yale, 1997) is taken from the northern portion of the island where supratidal conditions date back only to the early 1970's. The stratigraphy is similar to that from the older part of the island (Davis and Kuhn, 1985) with the gulfward portion being dominated by clean sand and shelly sand, and the landward portion by muddy sand. The basal unit is an organic-rich muddy sand that extends throughout most of the study area. The Miocene limestone is only a few meters below sea level under the island and crops out at the mainland shoreline. On cross sections where cores do not penetrate to bedrock, the control is based on probe-rod data.



Barrier-Island Cores and Transect





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Data references:

Color Infrared Digital Orthophoto Quarter Quadrangles (CIR DOQQ), (1994, 1995). USGS EROS Data Center, Sioux Falls, SD 57198. CD-ROMs.

Landsat TM Image, February 18, 1997, path 17, row 40. USGS EROS Data Center, Sioux Falls, SD 57198. CD-ROM.

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List of west-Florida coastal-transect series maps (1 sheet each):

Transect #1: Anclote Key, USGS Open-File Report 99-505
Transect #2: Caladesi Island-Clearwater Beach, USGS Open-File Report 99-506
Transect #3: Sand Key, USGS Open-File Report 99-507
Transect #4: Indian Rocks Beach, USGS Open-File Report 99-508
Transect #5: Treasure Island-Long Key, USGS Open-File Report 99-509
Transect #6: Anna Maria Island, USGS Open-File Report 99-510
Transect #7: Longboat Key, USGS Open-File Report 99-511
Transect #8: Siesta Key, USGS Open-File Report 99-512
Transect #9: Casey Key, USGS Open-File Report 99-513